
**Figure 1. A:** Four-year-old Valencia trees on Kuharske rootstock in the chemical trial for management of sting nematode **B:** The typical condition of root systems of trees in a nearby, similarly infested grove

# Evolution of sting nematode integrated pest management

By Homan Regmi, Larry Duncan and Johan Desaeger

Two field trials were initiated in a Polk County, Florida, commercial grove of 15-month-old Valencia on Kuharske trees in 2019 to measure the effectiveness of integrated pest management (IPM) tactics for managing sting nematodes (*Belonolaimus longicaudatus*). Six chemical nematicides, many newly released, were compared in one trial. In the second, perennial peanut plots were established in row middles as non-host cover crops and compared to plots of native vegetation for the ability to reduce the numbers of sting nematodes attacking the expanding root systems of young trees. Half of the trees with either peanut or native plants in row middles were treated each spring and fall with the nematicide oxamyl.

Trial results have been summarized annually in Citrus Industry, and this article describes results of the third and final season. The August 2020 and June 2021 issues provide background about sting nematodes and describe how the trials were conducted.

All products were applied at recommended rates. The four new chemistries were applied via microjets and were paired in order to treat the trees with alternating products in the spring and fall each year, because the application frequency of some of the products is restricted to once annually. Plant parasitic nematodes were measured each summer and winter, approximately two months following the spring and fall applications. Oxamyl was applied each spring and fall by spraying on the soil surface in the irrigated zone. Aldicarb granules were applied only in the spring to trees in plots that did not receive a fall nematicide application.

Although the experiments target sting nematode management, an overarching constraint for these and all citrus trees in Florida is the bacterial disease huanglongbing (HLB). The ubiquity of HLB occurrence in uncovered citrus has altered the requirements of all aspects of citriculture, from water and nutrient management to IPM. Tree decline following a major loss of roots and root function caused by the bacterial pathogen is frequently accentuated by other root pests and pathogens such as

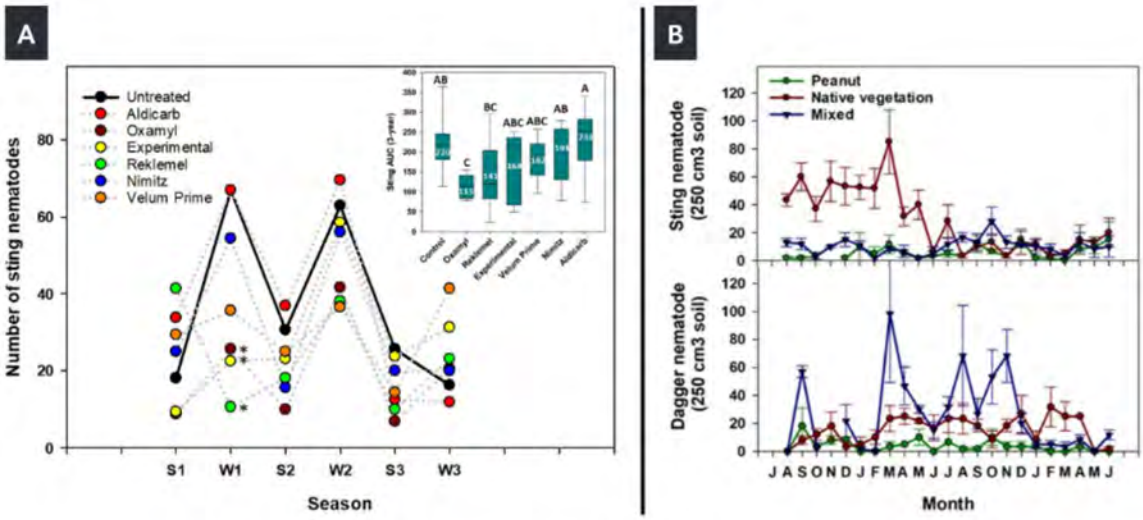


**Figure 2. A:** Effects of six nematicides on sting nematode populations measured in summer (S) and winter (W) of 2019–2021, and the total number of nematodes (AUC, "area under the curve") during three years **B:** The numbers of sting and dagger nematodes in row middles containing native vegetation, perennial peanut, or perennial peanut with significant weed infestation (mixed).

plant-parasitic nematodes, root weevils and *Phytophthora* spp.

In the case of sting nematode, the result can be stunted trees (Figure 1A, page 18) with greatly restricted root systems (Figure 1B, page 18). The 4-year-old trees at the conclusion of this study averaged just 5 feet tall, and most had sparse foliage, numerous dead branches and few fruit. The harvested yield was 35 boxes per acre. A critical question facing growers is whether these HLB-debilitated trees can respond sufficiently to management of other soilborne pests and diseases to be profitable.

## EFFICACY OF TACTICS

Oxamyl was consistently the most effective chemical treatment in reducing sting nematode populations (Figure 2A) and was the only nematicide to significantly reduce numbers of dagger nematodes (*Xiphinema vulgare*). Dagger nematodes were just 10% as numerous as sting nematodes in the chemical trial. The patchy distribution in soil of nematodes make populations especially difficult to measure accurately when densities are low.

Low populations may account for the especially poor performance of most products measured in the initial (summer 2019) and final (winter 2021) samples. Alternatively, 12 applications of oxamyl during three years could be enhancing microbial populations capable of metabolizing the compound, a process known as accelerated microbial degradation (AMD). Rotation of nematicides as a means to mitigate AMD is a potential option only recently available

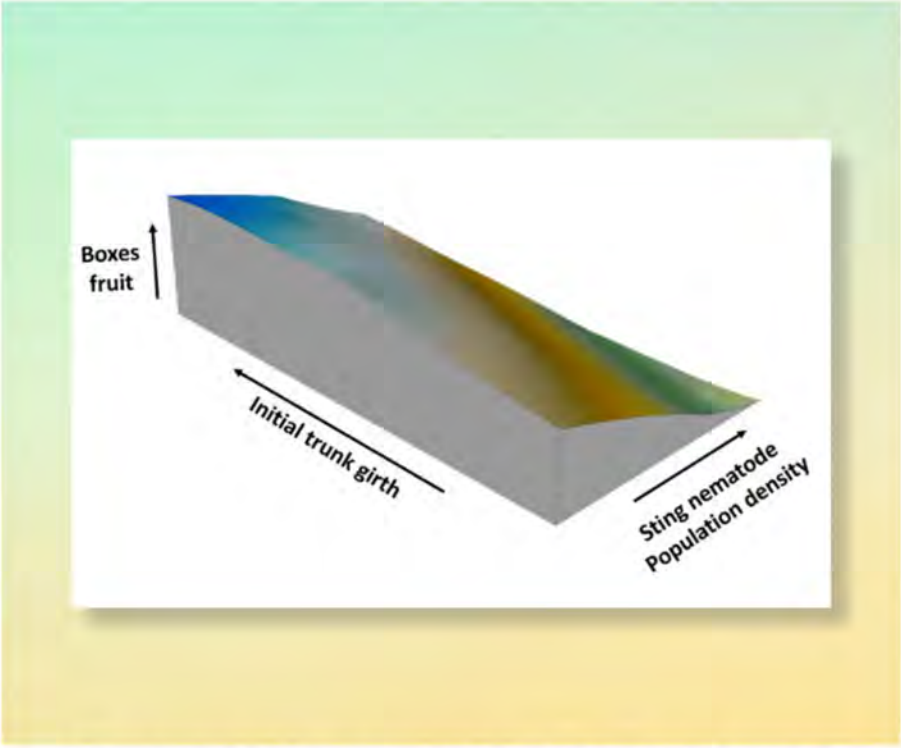


**Figure 3.** Citrus yield predicted by linear regression of the yield in spring 2022 against the size of the tree trunk at the beginning of the trial in winter 2019 and the numbers of sting nematodes measured during three years.

with the registration of new chemistries with different modes of action.

In laboratory studies, fluopyram (Velum Prime), fluensulfone (Nimitz) and fluazaindolizine (Reklemel) were at least as toxic to most plant-parasitic nematodes as oxamyl, with the benefit of exhibiting very low toxicity to mammals, birds, fish and many beneficial nematodes, unlike the highly toxic older carbamate nematicides such as oxamyl and aldicarb. In this trial, fluopyram provided no reduction of sting nematode, while fluazaindolizine, the experimental compound and oxamyl significantly reduced numbers of sting nematodes early in the trial, but not thereafter. The cumulative nematode numbers (AUC, "area under the curve") measured following the six seasonal treatments differed from those of the untreated plots only for oxamyl.

As noted in previous Citrus Industry articles, perennial peanut was confirmed to be suitable as a non-host cover crop against sting nematodes (Figure 2B, page 19). However, by summer of 2021, the sting nematode population density in the row middle declined by nearly an order of magnitude and has not increased, obscuring potential treatment differences.

Unlike in the citrus rows of the chemical or peanut trial, dagger nematode numbers were equivalent to those of sting nematode in these row middles. This difference in and between rows is unexpected since samples from citrus groves frequently contain abundant dagger nematodes. The population trends in the row middles suggest that perennial peanut is a very poor or non-host for both sting and dagger nematodes. There were significantly fewer dagger nematodes in peanut compared to either native vegetation or the peanut stands with heavy incursion of native vegetation.

## TREE RESPONSES

The oxamyl increased the fibrous roots by more than two-fold compared to untreated trees in the final trial year. Considered in terms of the original tree size, there were highly significant negative relationships between cumulative sting nematode population density (AUC) and the tree root mass, trunk growth and fruit production.

Figure 3 depicts the estimated (multiple linear regression) effects on yield of the original tree size and the 3-year cumulative citrus nematode population size. The largest trees in 2019 that subsequently experienced high sting nematode pressure

produced just 61% as much fruit as large trees experiencing low nematode numbers. The originally small, lightly infested trees produced a little more than half the fruit of larger trees. The small heavily infested trees produced just 15% as much fruit as the larger, lightly infested trees.

The only third-year effect of oxamyl treatments on the trees in the perennial peanut trial was a 33% increase in fibrous root density in trees, regardless of the plant cover in row middles. The fruit in this trial was inadvertently harvested without record. However, neither oxamyl nor peanut have affected tree size or condition to date.

## FUTURE RESEARCH

These trials illustrate two objectives needed for sting nematode IPM in trees susceptible to HLB: improved efficacy from available nematicides and additional management to overcome HLB-related root and yield loss.

An ongoing study using individual protective covers will compare the effects of nematicide treatments on trees with and without HLB. It is hoped that disease-free trees will respond even more strongly to nematode management to provide a larger and more productive tree when the covers are removed.

The new nematicides require studies to optimize rate, application timing and frequency, irrigation and injection times and duration, use of adjuvants to improve movement in soil, etc. This research is critical because of the demonstrated potential to increase yields by reducing sting nematode in groves currently devasted by it and HLB.

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